

CLAIMS

1 1. An optical device for routing a plurality of optical signals between a first
2 port and a second port in response to a control signal, the optical device
3 comprising:

4 at least one mirror array having a plurality of reflective elements, at least
5 one optical signal of the plurality being reflected from the first port by a
6 first reflective element of the plurality in a direction designated by the
7 control signal; and

8 at least one optical component for receiving the at least one reflected
9 optical signal from the respective reflective element, and for directing the
10 at least one reflected optical signal to at least one of the first and second
11 port by a supplemental reflective element, the optical component being
12 spaced from the at least one mirror array by a distance greater than a
13 Rayleigh range without scattering the at least one optical signal.

1 2. The optical device of Claim 1, wherein the at least one optical component
2 comprises a curved mirror.

1 3. The optical device of Claim 2, wherein the at least one mirror array
2 comprises:

3 a first mirror array; and

4 a second mirror array coupled with the first mirror array, wherein the first
5 reflective element of the first mirror array, in response to the control
6 signal, redirects the at least one optical signal to the supplemental
7 reflective element of the second mirror array.

1 4. The optical device of Claim 3, wherein the supplemental reflective
2 element is formed on the second mirror array, and in response to the control

3 signal, reflects the redirected at least one optical signal to at least one of the first
4 and second port.

1 5. The optical device of Claim 3, wherein the first mirror array and the
2 second mirror array are formed on a common substrate.

1 6. The optical device of Claim 3, wherein the at least one mirror array
2 comprises a MEMS mirror array.

1 7. The optical device of Claim 3, wherein the at least one optical component
2 comprises:

3 a bi-convex lens;

4 a patterned mirror embedded within the bi-convex lens, the patterned
5 mirror having reflecting and non-reflective portions, wherein

6 a second optical signal of the plurality, in response to the control
7 signal, is directed by a second reflective element of the first mirror
8 array to one reflecting portion of the patterned mirror, the one
9 reflecting portion reflecting the second optical signal to at least one
10 of the first and second ports; and

11 a third optical signal of the plurality, in response to the control
12 signal, is directed by a third reflective element of the first mirror
13 array through one non-reflecting portion of the patterned mirror
14 and to a fourth reflective element of the second mirror array, the
15 fourth reflective element directing the third optical input signal to
16 at least one of the first and second ports.

1 8. The optical device of Claim 7, wherein:

2 a fourth optical signal of the plurality, in response to the control signal, is
3 directed by a fifth reflective element of the second mirror array to another

4 reflecting portion of the patterned mirror, the another reflecting portion of
5 the patterned mirror reflecting the fourth optical signal to at least one of
6 the first and second ports; and
7 a fifth optical signal of the plurality, in response to the control signal, is
8 directed by a sixth reflective element of the second mirror array through
9 another non-reflecting portion of the patterned mirror to a seventh
10 reflective element of the first mirror array, the seventh reflective element
11 directing the reflected fifth optical signal to at least one of the first and
12 second ports.

1 9. The switch of Claim 9, wherein at least one reflective element of the
2 plurality has range equal to the sum of an incoming angle and an outgoing angle,
3 where

4 the incoming angle is equal to the inverse tangent of a length of the at
5 least one MEMS mirror array divided by twice the sum of a displacement
6 distance formed by the curved mirror and a Rayleigh range; and
7 the outgoing angle is equal to the inverse tangent of the length of the at
8 least one mirror array divided by twice the difference between the radius,
9 the Rayleigh range and the displacement distance.

1 10. An optical device for routing a plurality of optical signals between a first
2 port and a second port in response to a control signal, the optical device
3 comprising:

4 at least one curved mirror; and
5 at least one MEMS mirror array having a plurality of mirror elements,
6 wherein

7 a first mirror element of the plurality, in response to the control
8 signal, for reflecting a first optical signal of the plurality from at

9 least one of the first and second ports to the at least one curved
10 mirror;
11 the at least one curved mirror reflecting the first optical signal from
12 the first mirror element to a second mirror element of the plurality;
13 and
14 the second mirror element of the plurality, in response to the
15 control signal, for reflecting the reflected first optical signal from
16 the second mirror to at least one of the first and second ports, such
17 that the second mirror element is spaced from the at least one
18 curved mirror by a distance greater than a Rayleigh range without
19 scattering the reflected first optical signal.

1 **11.** The switch of Claim 10, wherein the at least one MEMS mirror array
2 comprises:
3 a first MEMS mirror array; and
4 a second MEMS mirror array optically coupled with the first MEMS
5 mirror array, wherein
6 a third mirror element of the first MEMS mirror array, in response
7 to the control signal, reflects a second optical signal of the plurality
8 from at least one of the first and second ports; and
9 a fourth mirror element of the second MEMS mirror array, in
10 response to the control signal, reflects the second optical signal
11 reflected by the third mirror element to at least one of the first and
12 second ports.

1 **12.** The switch of Claim 11, wherein the first MEMS mirror array and the
2 second MEMS mirror array are formed on a common substrate.

1 **13.** The switch of Claim 11, wherein the at least one curved mirror comprises:

2 a bi-convex lens;
3 a patterned mirror embedded within the bi-convex lens, wherein
4 a third optical signal of the plurality is reflected from a fifth mirror
5 element of the first MEMS mirror array to the patterned mirror, the
6 third optical signal being reflected from the patterned mirror to at
7 least one of the first and second ports;
8 a fourth optical signal of the plurality is reflected from a sixth
9 mirror element of the second MEMS mirror array to the patterned
10 mirror, the fourth optical signal being reflected from the patterned
11 mirror to at least one of the first and second ports; and
12 a fifth optical signal of the plurality is reflected from a seventh
13 mirror element of the first MEMS mirror array through the
14 patterned mirror and to an eighth mirror element of the second
15 MEMS mirror array, the eighth mirror element reflecting the
16 reflected fifth optical signal to at least one of the first and second
17 ports.

1 14. The switch of Claim 13, wherein a sixth optical signal of the plurality is
2 reflected from a ninth mirror element of the second MEMS mirror array through
3 the patterned mirror and to a tenth mirror element of the first MEMS mirror
4 array, the tenth mirror element reflecting the reflected sixth optical signal to at
5 least one of the first and second ports.

1 15. The switch of Claim 10, wherein at least one mirror element of the
2 plurality has range equal to the sum of an incoming angle and an outgoing angle,
3 where
4 the incoming angle is equal to the inverse tangent of a length of the at
5 least one MEMS mirror array divided by twice the sum of a displacement
6 distance formed by the curved mirror and a Rayleigh range; and

- 7 the outgoing angle is equal to the inverse tangent of the length of the at
- 8 least one mirror array divided by twice the difference between the radius,
- 9 the Rayleigh range and the displacement distance.